REMARKS

Claims 25, 30 and 39 have been amended. The amendments are supported by the specification and claims. No claims have been added or cancelled. Upon entry of the amendment claims 22 and 24-44 will be pending in the application.

The inclusion of the language "at least some" with reference to the amount of woodpulp fibres present in the web material is supported by the originally filed claims and specification.

This amendment is being filed under 37 C.F.R. 1.116 governing amendment after final rejection. This amendment is appropriate for entry under Rule 1.116 since it does not raise new issues and places the application in allowable condition and/or places the application in better form for consideration of appeal.

Entry of the amendment to claims 25, 30 and 39.

Claims 25, 30 and 39 each previously recited that the cellulosic web includes woodpulp fibres in an amount up to 50%. Use of the word "include" normally indicates the presence of the specified material. Despite this language the Examiner has pointed to the lack of a lower bound to assert that the language "includes woodpulp fibres in an amount up to 50%" can mean the presence of 0% or no woodpulp. Applicant has previously argued that the word include positively recites the presence of some wood pulp in the web material. The present Office communication at page 9 indicates that "if the Applicant incorporated a lower bound, then the claim would positively recite that some level of wood pulp fibers greater than 0 must be present." In sum, Applicant has consistently maintained that the language of claims 25, 30 and 39 positively recites the presence of wood pulp and the Examiner has counterasserted that the language of these claims does not positively recite the presence of wood pulp. Clearly, the presence of wood pulp in these claims is not a new issue. In essence, this rejection has been over the form of the claim and not the substance.

Applicant has amended claims 25, 30 and 39 to recite that the cellulosic fibres or web includes "at least some woodpulp fibres" in an amount up to 50%. Claims 25, 30 and 39 now unambiguously indicate that woodpulp is present. As stated in MPEP

§706.07(e), pp. 700-75, Rev. 1, Feb. 2003: ". . . amendments complying with objections or requirements as to form are to be permitted after final action in accordance with 37 CFR 1.116(a)." Applicant respectfully asserts that the claim amendment is proper for entry at this stage of prosecution.

In the event that the examiner refuses to enter the amendment to claims 25, 30 and 39, Applicant respectfully requests that the Remarks concerning the non-amended claims be considered.

The rejection of claim 22-36 under 35 U.S.C. §112, second paragraph.

Claims 22-36 were rejected under 35 U.S.C. §112, second paragraph, as allegedly being indefinite. This Office communication refers to the previous October 3, 2003 Office communication for details of this rejection. The October 3, 2003 Office communication states that: "it is unclear what nonwoven webs would possess a lower cross direction wet expansion when compared to a similar web material comprising only the same cellulosic fibers because the Applicant has not set forth a comparative value in the claim."

The legal precedent on claim language is summarized in MPEP §2173.01. That section states:

> "A fundamental principal contained in 35 U.S.C. 112, second paragraph is that applicants are their own lexicographers. They can define in the claims what they regard as their invention essentially in whatever terms they choose so long as the terms are not used in ways that are contrary to accepted meanings in the art. Applicant may use functional language, alternative expressions, negative limitations, or any style of expression or format of claim which makes clear the boundaries of the subject matter for which protection is sought. As noted by the court in In re Swinehart, 160 USPQ 226 (CCPA 1971), a claim may not be rejected solely because of the type of language used to define the subject matter for which protection is sought."

Further, as stated by the Court in Miles Laboratories Inc. v. Shandon Inc., 27 USPQ2d 1123, 1126 (Fed. Cir. 1993), "If the claims read in light of the specification reasonably apprise those skilled in the art of the scope of the invention, §112 demands no more."

Claim 22 recites: "A nonwoven web material comprising cellulosic fibres and synthetic fibres, . . .". Claim 22 is clearly directed to a nonwoven web material comprising both cellulosic fibers and synthetic fibers. Claim 22 goes on to recite, with bracketed text added: "wherein the {cellulosic fiber and synthetic fiber} web material exhibits lower cross direction wet expansion than a similar web material comprising only the same cellulosic fibres." This recitation is a comparison of the properties of the inventive cellulosic and synthetic fiber web material to a different web material comprising only cellulosic fibers and without the synthetic fibers.

- Applicant's specification at page 8, line 23 to page 9, line 6 provides a method for testing wet expansion of a web material.
- Example 1, (page 9) provides CD wet expansion data from the center of 3 web materials: 100% abaca fiber web; 94% abaca fiber and 6% polyester fiber web (Test 1); and 94% abaca fiber and 6% polyester fiber web (Test 2).[1]
- Example 1, (page 9) provides CD wet expansion data from an edge for 3 web materials: 100% abaca fiber web; 94% abaca fiber and 6% polyester fiber web (Test 1); and 94% abaca fiber and 6% polyester fiber web (Test 2).
- Example 1, (page 9) provides CD wet expansion data for a maximum to minimum range at 16 positions across 3 web materials: 100% abaca fiber web: 94% abaca fiber and 6% polyester fiber web (Test 1); and 94% abaca fiber and 6% polyester fiber web (Test 2).
- Figure 1 graphically displays CD wet expansion data at 16 positions across 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web (Test 1).
- Example 2, (page 10) provides CD wet expansion data from the center of 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.

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[1] Examples 1-3 indicate that the web material was 96% abaca and 6% polyester, which is not possible. The specification at page 8, lines 10-12 indicates that Examples 1 to 3 were produced from 94% abaca fibers and 6% polyester fibers. Example 4 is presumed to be the same 94% abaca, 6% polyester combination.

- Example 2, (page 10) provides CD wet expansion data from an edge for 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 2, (page 10) provides CD wet expansion data a maximum to minimum range at 16 positions across 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 3, (page 10) provides CD wet expansion data from the center of 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 3, (page 10) provides CD wet expansion data from an edge for 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 3, (page 10) provides CD wet expansion data a maximum to minimum range at 16 positions across 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 4, (page 11) provides CD wet expansion data (mean) for 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.
- Example 4, (page 11) provides CD wet expansion data at 16 positions across 2 web materials: 100% abaca fiber web; and 94% abaca fiber and 6% polyester fiber web.

In sum, Applicant's specification provides <u>fourteen (14) examples</u> wherein a web material made according to the claims (in the examples - 94% abaca fibers and 6% polyester fibers) is compared to a similar web material comprising only the same cellulosic fibers (100% abaca fibers). For each of these examples the CD wet expansion of the novel web material is lower than the CD wet expansion of a material comprising only the same cellulosic fibers. This lower expansion is also graphically indicated in Figure 1.

In view of the many examples within their specification Applicant's respectfully assert that the pending claims are legally definite as "the claims read in light of the specification reasonably apprise those skilled in the art of the scope of the invention". Applicant respectfully urges the Examiner to reconsider and withdraw this rejection of claims 22-36 under 35 U.S.C. §112, second paragraph.

The rejection of claims 22 and 24-44 under 35 U.S.C. §103(a).

Claims 22 and 24-44 were rejected under 35 U.S.C. §103(a) as being obvious over International publication WO 95/10190 to Rose et al. in view of U.S. Patent No. 5,705,214 to Ito et al. In making this rejection the Examiner asserts that "Rose teaches a porous substrate such as a paper comprising natural cellulosic fibers mixed with synthetic fibers" (Office communication, page 3, ¶3). The communication admits at page 5, ¶3 that "Rose . . . however fails to teach that the synthetic fibers in the porous substrate are selected from polyester, polyester copolymer, polyamide, polyamide copolymer, polyolefin and polyolefin copolymer or a mixture thereof." The Examiner than speculates that:

> It would have been obvious and necessary for one of ordinary skill in the art practicing the invention of Rose to provide the details of the synthetic fiber. As polyester and nylon (polyamide) are commonly employed synthetic fibers which provide reinforcement and heat stability to a casing material, it would have been obvious to one of ordinary skill in the art at the time the invention was made to use polyester or nylon as the synthetic fiber as suggested by Ito in the invention of Rose, motivated by the expectation of successfully practicing the invention of Rose.

As stated in MPEP §2143, to establish a *prima facie* case of obviousness three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

- **There is no suggestion or motivation to modify the Rose reference.**

The Office communication asserts that the required motivation for the cited combination of the Rose and Ito references is: "the expectation of successfully practicing the invention of Rose." The Rose reference at page 4, lines 10-21 states:

> Preferably the porous substrate is a wet laid fibrous substrate, most preferably a paper. Most preferably the paper is of a high and uniform permeability (preferably 100 – 200 $m^3\ min^{-1}\ m^{-2}$) and of low basis weight (typically 10 – 30 gsm). Preferably also the paper has a tensile ratio (i.e.

ratio of machine direction:cross direction strength) of 0.5 - 2.0 more preferably in the range of 1.0 – 1.5. The paper is ideally prepared from "long" fibers (e.g. 5mm) of high aspect ratio (e.g. 300 – 3000). The web's constituent fibers should also exhibit uniform formation and absorbency characteristics. Particularly suitable papers are composed of natural cellulosic fibers typically of the Musa Textilis species (e.g. Abaca). It is also possible to use papers comprised wholly or partially of synthetic fibers.

Example 1 (Rose, page 8) is a 100% abaca fiber paper. Example 2 (Rose, page 9) is a 100% abaca fiber paper. Example 3 (Rose, page 9) is a 100% abaca fiber paper. As explained at page 4, lines 18-20 of the Rose reference, abaca fibers are natural cellulosic fibers. There is no other disclosure in the Rose reference concerning the web fiber composition.

The Rose reference at page 4, lines 16-18 states, with bolding added: "The **web's constituent fibres** should also exhibit uniform formation and absorbency characteristics." Clearly, the Rose recitation of "the web's constituent fibres" is explicitly referring to each fiber and fiber type in the web material and not to properties of the web as a whole; that is, according to Rose each fiber in the web should have uniform formation and absorbency characteristics. The Rose reference goes on to teach that absorbent fibers, particularly natural cellulosic fibers such as abaca, are "particularly suitable" for use in the process therein.

The Rose reference also states at page 4, lines 20-21 that: It is also possible to use papers comprised wholly or partially of synthetic fibers. Enclosed herein is:

- a copy of a portion of a web page from http://www.uspto.gov/go/classification/uspc162/defs162.htm#C162S157100 (the U.S. PTO website) indicating that class 162, subclass 157.1 defines "synthetic fiber" to include chemically modified cellulose such as regenerated cellulose, e.g. rayon, as well as synthetic resins.
- a copy of a web page from www.hyperdictionary.com indicating that a synthetic fiber is "created from natural materials or by chemical processes."
- copies of two web pages from www.minifibers.com indicating that synthetic fibers include rayon, nylon, polyester, acrylic and polypropylene.

Clearly, the U.S. PTO as well as the art considers the term synthetic fibers to include rayon, nylon, polyester, acrylic and polyolefin materials.

Enclosed herein are two web pages from Washington State University, Department of Apparel, Merchandising, Design and Textiles, located at http://amdt.wsu.edu/classes/salusso/amt215/amt215/class%20schedule/class%20notes /fiberperformancesummary.pdf titled "SUMMARY OF TEXTILE FIBER PERFORMANCE". These pages indicate that cellulosic fibers, such as the abaca fibers used in the Rose reference, have good absorbency. Synthetic fibers such as Rayon also have high absorbency. Contrastingly, other synthetic fibers such as nylon, polyester, acrylic and olefin have low absorbency. Summarized:

- The Rose reference explicitly teaches that, with bolding added: "The web's **constituent fibres** should also exhibit **uniform** formation and **absorbency characteristics.**"
- Cellulosic fibers such as natural abaca fibers and synthetic Rayon fibers exhibit uniform absorbency characteristics (good and high absorbency, respectively).
- Synthetic fibers such as nylon, polyester, acrylic and olefin fibers exhibit very different absorbency characteristics from cellulosic fibers (low absorbency vs. good or high absorbency).

Given the explicit Rose teaching that all of the web material constituent fibers should have the same absorbency, there is no suggestion or motivation in the cited references to use the low absorbency synthetic fibers disclosed in the Ito reference with the good or high absorbency fibers disclosed in the Rose reference. Applicant respectfully traverses the rejection of claims 22 and 24-44 and asserts that these claims are patentable for at least this reason.

- **There is no expectation of success in modifying the Rose reference.**

The Rose reference is directed to impregnation of a web material with a liquid binder composition. As would be expected, the Rose reference teaches that the constituent fibers making up that web should have uniform absorbency so that the liquid

binder composition will be uniformly absorbed by the web. Adding the low absorbency synthetic fibers of Ito to the good to high absorbency web material of Rose is contrary to the teachings of Rose and logically would be expected to decrease the web material absorbency desired by Rose. A person of ordinary skill in the art would have no expectation of success in modifying the Rose material as proposed in the Office communication. Ito is also silent as to why this teaching in Rose should be modified. Applicant respectfully traverses the rejection of claims 22 and 24-44 and asserts that these claims are patentable for at least this reason.

- **The Rose reference teaches away from modification as proposed in the Office communication.**

A reference that teaches away from a claimed invention does not provide the suggestion or motivation needed to anticipate or make obvious a claimed invention. In fact, the courts have stated that a reference that teaches away from a claimed invention is an indication of the nonobviousness of that invention. "A reference, however, must have been considered for all it taught, disclosures that diverged and taught away from the invention at hand as well as disclosures that pointed towards and taught the invention at hand." Ashland Oil, Inc. v. Delta resins & Refractories, Inc., 227 USPQ 657, 666 (Fed. Cir. 1985). "One important indicium of nonobviousness is 'teaching away' from the claimed invention by the prior art." In re Braat, 16 USPQ2d 1813, 1814 (Fed. Cir. 1990). The prior art reference must be considered in its entirety, including portions that would lead away from the claimed invention. See MPEP 2141.02.

The Rose reference explicitly teaches at page 4 that: "The web's constituent fibres should also exhibit uniform . . . absorbency characteristics." The Rose reference goes on to teach that absorbent fibers, particularly natural cellulosic fibers (pp. 4 and Examples 1-3), are "particularly suitable" for use in the Rose web material. Thus, the Rose reference explicitly teaches away from adding the low absorbency synthetic fibres of Ito to the web material of Rose. Ito is also silent as to why this teaching in Rose should be modified. Applicant respectfully traverses the rejection of claims 22 and 24-44 and asserts that these claims are patentable for at least this reason.

Claims 25, 30 and 39 are patentable for additional reasons.

Amended claim 25 recites: "The web material of claim 22 in which the cellulosic fibres include at least some woodpulp fibres in an amount of up to 50% by weight of a total weight of cellulosic and synthetic fibres." Claim 25 thus requires the presence of wood pulp in the web material. As discussed above, Applicant has consistently maintained throughout this prosecution that claim 25 positively recites the presence of some amount of wood pulp.

The Office communication on page 3, ¶5 states that "Rose does not specifically teach the use of wood pulp fibers as a cellulosic fiber in the substrate. Claim 25 includes the presence of some woodpulp. Applicant respectfully traverses the rejection of claim 25 and asserts it should be withdrawn. Claims 30 and 39 recite similar features and are patentable for similar reasons.

Claims 26, 27, 40 and 41 are patentable for additional reasons.

The Office communication at page 6, ¶2 states that Rose in view of Ito does not include the use of synthetic fibers as specified in Applicant's claims in the amounts specified in claims 26-27 and 40-41. The Office communication, apparently attempting to address the fact that the synthetic fiber ranges in Applicant's claims and the Rose reference do not overlap, states:

> It should be noted that the amount of cellulosic and synthetic fibers in the substrate are result effective variables; for example, as the amount of cellulosic fibers increases, the web will become more paper-like. As the amount of synthetic fiber increases, the substrate will become more heat stable. It would have been obvious to one having ordinary skill in the art at the time the invention was made to Rose, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). In the present invention, one would have been motivated to optimize the level of cellulosic and synthetic fibers to create a substrate with properly balanced elasticity, thermal stability and strength.

- **The communication reliance on the cited Boesch case is misplaced.**

The citation referred to in the communication, at 205 USPQ 215, 219 (CCPA

1980), states:

> **[1]** In the above-quoted passage from '838, we note that lowering the N_v value of a Co-Cr-Ni alloy and depletion of the metals not consumed in precipitation from the N_v calculation are expressly suggested. Considering, also, that the composition requirements of the claims and the cited references overlap, we agree with the Solicitor that the prior art would have suggested "the kind of experimentation necessary to achieve the claimed composition, including the proportional balancing described by appellants' Nv equation." This accords with the rule that discovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art.

Thus, the decision in the Boesch case relied on 1) the cited reference "expressly" suggesting the relationship between the variable and the result; 2) the claimed ranges and cited reference ranges overlapping; and 3) the prior art suggesting "the kind of experimentation necessary to achieve the claimed composition . . . described by appellants. The facts of the present situation are completely different from the facts of Boesch.

- As discussed above, the Rose reference fairly teaches away from using ANY amount of the low absorbency fibers of Ito.
- There is no teaching or suggestion in Rose that synthetic fiber concentration affects cross direction wet expansion. The Rose reference DOES teach that impregnating a preferred natural cellulose web material with a liquid dispersion of a polymer and subsequent crosslinking of the polymer affects cross direction stretch.
- The Rose reference does not appear to provide ANY guidance as to the amount of low absorbency synthetic fibers that may be used.
- The Rose reference does not teach or suggest use of the low absorbency synthetic fibers of Ito at about 0.5% to about 20%. There is no overlap between Applicant's claimed synthetic fiber amounts and any teaching or suggestion in the Rose reference.
- Given the teaching in Rose that, with bolding added: "The web's **constituent fibres** should also exhibit uniform . . . absorbency characteristics" a person of ordinary skill would be taught away from "the kind of experimentation necessary

to achieve the claimed composition" of Applicant's.

Applicant traverses the communication statement that "the amount of cellulosic and synthetic fibers in the fibrous web are result effective variables" under Boesch in view of the contrary teachings of the cited Rose reference. Claims 26-27 and 40-41 are patentable for at least this reason.

- **Claim 29 is patentable for additional reasons.**

Claim 29 recites in one pertinent part: "A method for lowering cross direction wet expansion of a nonwoven web material comprising: mixing cellulosic and synthetic fibres selected from at least one of polyamide fibres, polyamide copolymer fibres, polyester fibres, polyester copolymer fibres, polyolefin fibres and polyolefin copolymer fibres; and forming the mixed fibres into the nonwoven web . . ." As discussed above there is NO teaching or suggestion in the Rose reference that synthetic fibers of the classes recited in claim 29 can be used. In fact, as also discussed above, the Rose reference fairly teaches away from the use of low absorbency synthetic fibers with good or high absorbency cellulosic fibers. Claim 29, and claims dependent therefrom, are patentable for at least this reason.

It is believed the application now stands in condition for allowance, and prompt favorable action thereon is respectfully solicited.

The Examiner is invited to telephone Applicant(s)' attorney if it is deemed that a telephone conversation will hasten prosecution of this application.

Respectfully submitted,

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157.1 Synthetic fiber (including chemically modified cellulose):
This subclass is indented under **subclass 100**. Processes and products which include synthetically produced fibers or chemically modified natural fibers.

(1) Note. This subclass takes the formation of felted products from such fibers as regenerated cellulose, cellulose ethers and esters, synthetic resins, and wool-like cellulosic fibers, as well as such formation combined with the synthetic production or chemical modification of the fibers, in any sequence.

(2) Note. This subclass includes the products under "E." of the class definition of this class.

hyperdictionary

Meaning of SYNTHETIC FIBER

WordNet Dictionary

Definition: [n] created from natural materials or by chemical processes

Websites:
- **Buy Synthetic Fiber Products**
  We link to merchants which offer Synthetic Fiber products for sale.
  bounce.deal-market.com

Synonyms: man-made fiber

See Also: acrylic, acrylic fiber, fiber, fibre, nylon

20.0	43.41	1.71	18.18
25.0	48.55	1.91	22.73

Length

The length of the preferred fiber is directly related to the diameter. This is referred to as the aspect ratio. Aspect ratio is found by dividing the length of the fiber by the diameter (using the same unit of measure for each). The ideal aspect ratio is 500:1. An example follows:

Length = 250 mils
Diameter = 0.491 mils
L/D = 250/0.491 = 509

When the correct aspect ratio is used, you receive an optimum amount of strength, as well as good dispersion. As the aspect ratio increases, the fiber becomes more difficult to disperse; as it decreases, there is a loss of strength resulting from poor binding capability.

End Condition

Diameter and length are both very important factors, but if there is a poor end condition on cut fiber, all has been in vain. We like to refer to our product as precision-cut fiber -- fiber in which all ends are squarely cut and not fused together.

Any end condition that tends to entangle another filament is not acceptable. Such end conditions are the split end, the fused end, the fused log, and the fused daisy.

Even though it may be possible to eventually cause poorly cut fiber to disperse, much valuable time is wasted, and the risk of an inferior web still exists.

SYNTHETIC FIBERS

We will limit our discussion to our common stock fibers: acrylic, rayon, nylon, polyester, and polypropylene. Our main intent is to discuss the most frequently asked questions about synthetic fibers.

Rayon

For many centuries, there had been a dependency on natural fibers; therefore, the first man-made fiber was one which possessed many of the same characteristics. Thus evolved rayon, a regenerated cellulose very similar to cotton. Rayon has a high moisture absorbency, with a normal moisture regain of 11-13%. This enables it to be very versatile and helps to prevent it from generating static electricity. The rayons most familiar to our industry are flocking tow and high tenacity tire cord.

Rayon flocking tow is moderate in tenacity, normally about 1.9 to 2.3 grams per denier (gpd). The typical elongation at break is 20-25%. It is a soft and pliable fiber with an average stiffness of 6 to 6.16 gpd. It does not melt; however, there is a loss of strength at about 300°F, and decomposition occurs at 325 to 464°F when exposed for extended periods of time. Hot dilute and cold concentrated acids will disintegrate the fibers. Strong alkalis tend to swell the fiber and cause loss of strength. Our standard deniers for flocking tow are 1.5, 3.0, and 4.5 dpf, though many deniers are available.

When it has a proper aspect ratio and is well cut, rayon flocking tow is one of the easiest man-made fibers to disperse in both aqueous and non-aqueous systems. It is often used in combination with other synthetic fibers, especially when a web of high absorbency is desired in conjunction with a higher tensile strength. One of the most popular blends is flocking tow and polyester. There are many areas of application, but two of the most familiar are disposables, such as baby diapers, and filter media.

High tenacity rayon, commonly referred to as tire cord, differs somewhat from flocking tow in that its tenacity can be as high as 5.3 gpd. It is often used in webs where dimensional stability and rigidity is desired. The average stiffness varies from 13 to 50 gpd depending upon the manufacturer. Since it cannot be fused in the fiber cutting process, rayon tire cord is also an easily dispersed fiber.

Nylon

Nylon is the first hot-melt fiber to be commercially produced. The fiber forming substance in nylon is a long-chain synthetic polyamide with less than 85% of the amide linkages attached directly to two aromatic rings. There are many varieties of nylon; therefore, we will limit this discussion to the regular tenacity nylon which is stocked by MiniFibers.

Our regular tenacity nylon fibers are 1.8, 3.0, 6.0, and 15.0 dpf and have a tenacity of 2.3 to 6.0 gpd. Nylon is a fairly rigid fiber. The stiffness of regular tenacity nylon is 5.0 to 24.0 gpd. Average toughness values are .21 gpd for regular tenacity nylon.

This combination of properties has resulted in numerous applications for nylon, including those where rayon and others have failed. Nylon has a higher melting point - about 500°F. It has low moisture absorbency, and therefore dries quickly. It is superior in abrasion resistance and has excellent stretch and recovery properties. It is affected by mineral acids but resists most alkalis. Two popular applications of nylon are industrial filters and adhesive backing.

Polyester

Polyester is perhaps the most interesting of all the synthetic fibers. There are numerous areas of application because of its physical characteristics and relatively low cost. Polyester, which is often referred to as PET (polyethylene terephthalate) melts at 495°F and has a good resistance to most acids and alkalis. It provides strength and resilience and gives excellent dimensional stability to a web.

There is a multitude of types of polyester; therefore, we will discuss in general terms the regular tenacity and high tenacity polyesters stocked by MiniFibers. Our regular tenacity polyester is 3.0 dpf with a tenacity of approximately 4.0 to 5.0 gpd. Our high tenacity polyesters are 6.0 and 12.0 dpf with a tenacity of 6.8 to 9.2 gpd. When regular tenacity polyester is used, a very flexible web is produced, whereas high tenacity polyester produces a much more rigid web. The average stiffness of high tenacity polyester can be up to 77 gpd, the highest of the commonly used synthetic fibers.

There are many different trade names for polyester, and just as many applications. Filter media, felts, disposables, and wallcoverings are just a few of the many products in which it is used.

Acrylic

Acrylic is a synthetic fiber formed in a polymerization process and composed of at least 85% by weight of acrylonitrile monomer. Acrylic has a tenacity of 2.5 to 3.0 gpd and an average stiffness of 6.0 to 8.0 gpd. This fiber has a generally good resistance to mineral acids and weak alkalis, and a moderate resistance to strong alkalis at room temperature. A high tensile strength of 30,000 to 45,000 psi and an elongation at break of 25-40% are also characteristic of acrylic fibers.

Acrylic does not melt, decomposes at temperatures in excess of 500°C, and maintains some integrity after burning, making it an ideal substitute for the more expensive, specialty fibers frequently used in high heat applications. It can be fibrillated to provide more surface area. The most common applications which utilize acrylic fibers are water filtration, cementitious products, and friction products.

Polypropylene

Polypropylene, one of the olefins, is a long-chain synthetic polymer composed of at least 85% of propylene. It is an exceptionally lightweight fiber resulting in webs of good bulk and coverage. Its toughness and abrasion resistance is exceeded only by nylon. Polypropylene has a tenacity of 2.5 to 5.5 gpd and a low melting point of 320°F; therefore, it is an excellent binder. Polypropylene has an excellent resistance to acids and alkalis; however, it is not resistant to oxidizing agents.

One form of polypropylene that has grown in importance is the fibrillated synthetic pulp, which gives more surface coverage. It became popular as a replacement for asbestos where resistance to very high temperatures is not required.

With the above fiber descriptions at hand, it will now be easier for you to decide which generic type of synthetic fiber fits your need. As you consider all of the above points, you will be better able to choose the specific type of fiber, denier, and length for your next web.

SUMMARY OF TEXTILE FIBER PERFORMANCE

Protein Fibers Common Properties

- Hygroscopic>> high absorbency so comfortable when damp & cool (London)
- Good conductor of heat>> keeps body's sweat off the skin
- Resilient>> resists wrinkling; wrinkles fallout when hang in damp shower
- Relatively light>> light weight compared to cellulosic
- Weaker when wet>>abrasion of washing machine more harmful than water; be gentle!
- Harmed by alkali>> use neutral detergents, sweat will weaken so clean textiles before storing
- Harmed by oxidizing agents>> chlorine bleach & sunlight yellows fabrics
- Harmed by dry heat>> use steam! keep heat in protein range
- Flame resistant>> does not burn easily, self-extinguishes if thick enough fabric
- Chemically bond with dye--Outstanding dyeing potential
- Color subject to damage from acids, sunlight, detergent, body chemical
-

Cellulosic Fibers Common Properties

- Good absorbency>>comfortable on skin
- Good conductor of heat >>cool when warm
- Poor insulator >> allows body to cool
- Withstands high temperature> irons well
- Low resiliency & loft > wrinkles easily
- Conduct electricity> little static
- Subject to linting> fabric thins with abrasion
- Subject to significant shrinkage
- Holds dye poorly so fade easily
- Heavy fibers> best for keeping cool not warm
- Harmed by mineral acids> remove stains quickly
- Attached by mildew> Store clean, dry
- Attached by silverfish, crickets> store clean, dry
- Flammable> avoid sources of ignition
- Moderate sunlight resistance> line drapes
- Microscopic identification possible

Environmental Issues of Natural Fibers

- Natural fibers subject to climate, weather
- Considerable water and energy used to process natural fibers
- Dye cleaning some natural textiles has it's own environmental impact

Acetate vs. Regenerated Cellulosics

Acetate	**Rayon**	**Lyocell**
Mostly filament	mostly staple	both
Resiliency low	Low	moderate
Abrasion resist low	medium	high
Strength low	low	medium
Melts	ironed like cotton	
Med absorbency	high absorbency	
Static builds up	no static	
No mildew	mildew prone	
Low cost	low	moderate
Dry clean only	dry clean or wash	

Acetate	Rayon	Lyocell
Chlorine Bleach Ok	OK	OK
Sunlight resistance moderate for all 3		
Identification sorted by solubility for all 3		
Strong acids harm all 3		
Alkali resistance moderate for all 3		
Solvents melt	resistant to solvents	
Solution dyeing improves	color issues continue	
Color fume fades color crocks		

Synthetic Fibers Common Properties

- Typical=nylon, polyester, acrylic, olefin
- 69% of world-wide fiber use is synthetic; cotton is 30%; other = 1%
- Made from chemicals, usually petroleum
- Relatively light weight for volume
- Fibers spun from chemical into filament form
- Fibers can then be
  - Kept as smooth filaments
  - Cut to stapled form
  - Modified into textured filaments
- Resistant to most chemicals
- Medium to high abrasion resistance
- Medium to high strength
- High resilience
- Medium to high sunlight resistance
- Heat sensitive (some flammable, most melt)
  - shrink, melt from heat
  - Create Cire, heat-set pleats, surface designs, 3-D
  - texturize yarns
  - Heat-set dimensions
- Resistant to insects, mildew, fungi, rotting
- Only solubility testing conclusive fiber ID
- Oleophylic- attracts oil-based stains, dry clean
- Subject to static--static cling, shocks, sparks
- Subject to pilling--static + stapled fibers, blends, or
- Can 'pick up' misc. fibers, ie. Pet hair, DIRT
- Resistant to moisture, low absorbency
  - Drys quickly
  - Little shrinkage when wet
  - Resists water based stains
  - Uncomfortable if humid or physically active
- Environmental impact of synthetics
  - Production of fibers engineered so less environmental cost than natural fibers
  - Use of fibers can be done well or poorly
    Recyling synthetics can mediate impact